AMENDMENTS TO THE SPECIFICATION:

Please replace the consecutive paragraphs beginning on page 15 and ending on page 18 with the following amended paragraphs:

After the two assemblies 300 and 400 are joined, the elements may be further isolated in the elevation dimension (step 208 in Figure 2) by making further elevation aperture cuts 504 and 506 from the exposed surface of piezoelectric assembly 400 to gaps 406 and 408, or to any other depth. With reference now to Figure 5(b), aperture cuts 504 and 506 may be made with a dicing saw or other device to acoustically isolate adjoining transducer elements. Isolation may be enhanced by filling the cuts with acoustically attenuative material, as described above in conjunction with material 314 and below in conjunction with Figure 8. The material used is suitably a polymer having properties of attenuation, longitudinal and shear acoustic velocities, and acoustic impedance that suit the properties of the piezoelectric material. The polymer chosen may minimize (or at least reduce) lateral modes and cross-talk between ceramic aperture strips, as appropriate. The material used to fill cuts 504 and 506 may be identical to material 314 used in matching layer assembly 300, or the two materials may be different. For example, a material that may be used to fill elevation apertures 504 and 506 could be a filled polyurethane such as Shore A80 polyurethane available from Ciba Inc. After the acoustically-attenuative material is cured, a ~~piezoelectric~~ substrate assembly 500 having electrical and acoustic isolation between elements in the elevation direction is appropriately complete, and ready for processing in the azimuth direction.

With momentary reference again to Figure 2, processing the ~~piezoelectric~~ substrate assembly 500 in the azimuth direction suitably includes making minor element cuts (step 210), attaching signal leads (step 212), and making major element cuts in the elevation direction (step

214). Figures 6(a), (b), and (c) are exemplary ~~side~~ top views of these respective steps. With reference now to Figure 6(a), minor element cuts 602 are made in the elevation direction with a dicing saw or other device. Minor element cuts 602 may be made through the entire ~~piezoelectric~~ substrate assembly 500, as appropriate, or may be made only part of the way through substrate assembly 500 (e.g. only as far as conducting layer 108 (Figure 1)). Minor element cuts 602 suitably increase the thickness mode vibration of the transducer element by producing "sub-elements", thus improving the efficiency of the transducer; nevertheless, minor element cuts are optional cuts that may be omitted in various alternate embodiments. The minor element cuts 602 (which correspond to minor element cuts 122 in Figure 1) may be of any kerf width, such as on the order of about 5-100 microns. In an exemplary embodiment, the kerf width of the minor element cuts is about 30 microns, although of course other kerf widths could be used.

After the minor element cuts 602 are made in ~~piezoelectric~~ substrate assembly 500, signal leads 606 may be affixed as appropriate. With reference now to Figure 6(b), a flex circuit 604 may be applied to each elevation strip in the transducer array. Flex circuit 604 suitably includes a number of signal lead sections 606 separated by insulating/isolating regions 612. Signal lead sections 606 suitably correspond to individual transducer elements. An example of a flex circuit is available from the Unicircuit corporation, which includes a number of conductor leads 606 embedded in a polymide or similar film. Of course, any signaling leads, circuits or other schemes could be used in altermate embodiments. For example, individual leads could be suitably positioned and connected to each element in the transducer.

Flex circuit bus 604 may be aligned to the ~~piezoelectric~~ substrate assembly 500 by any technique. In exemplary embodiments, a "v-notch" 608 may be laser-etched or otherwise

marked on flex circuit bus 604 prior to placement. Although various configurations of the v-notch could be formulated, one embodiment involves making a line from a center of at least one conductor lead 606 to the edge of the lead. Alternatively, an arrow or other marker could be made on flex circuit bus 604 that may be aligned with one of the minor element cuts 602 in ~~piezoelectric~~ substrate assembly 500. Alignment may take place by viewing the minor element cuts 602 and v-notch 608 through a microscope or other viewing device to properly position flex circuit bus 604 as appropriate. Flex circuit bus 604 may be affixed to ~~piezoelectric~~ substrate assembly 500 by soldering the leads to a metallized surface of the elements, by affixing with glue, epoxy or other adhesive, or by any other technique.

After the signal lines 606 are attached to ~~piezoelectric~~ substrate assembly 500, major element cuts 610 in the elevation direction may be made. With reference now to Figure 6(c), major element cuts 610 may be made with a dicing saw or other device to isolate the various elements in the azimuth direction. Like the minor element cuts 602, major element cuts 610 may be made through the entire ~~piezoelectric~~ substrate assembly 500 to completely isolate the various elements. Alternatively, major element cuts 610 may be made only part of the way through substrate assembly 500, for example to conducting layer 108 (Figure 1). In various embodiments, the kerf width of major element cuts 610 may be equal to or wider than the kerf width of minor element cuts 602. Although any kerf width could be used, an exemplary embodiment uses a kerf width of about 50 microns to isolate the various elements in the azimuth direction. The use of narrow sub-element kerfs and wider major element kerfs may contribute to maintaining the overall element aspect ratio, which influences thickness mode elemental response, and may also reduce inter-element cross-talk due to the wider gap between adjacent elements. In the exemplary embodiment shown in Figure 6(c), major element cuts are made

through flex circuit 604 from elevation isolation cut 504 into the insulation/isolation regions 612 of flex circuit 604, as appropriate, to suitably electrically isolate the leads 606 connected to each individual element.

After the various elements in ~~piezoelectric~~ substrate assembly 500 have become isolated in both the elevation and azimuth dimensions, assembly 500 may be placed into a transducer housing (step 216 of Figure 2). Figure 7 is a cross-sectional view of an exemplary transducer 700 having a transducer assembly 500 as described above in conjunction with one or more ground leads 706, a backing material 702, and an acoustic lens 704. In the embodiment shown in Figure 7, six elements are present in the elevation dimension, although of course more or fewer elements could be used in various other embodiments.

Please replace the paragraph at the bottom of page 18 with the following paragraph:

Signal ground leads 706 may be electrically coupled to piezoelectric assembly ~~500~~ 400. As shown in Figure 7, the ends 708 and 710 of piezoelectric assembly ~~500~~ 400 have been metallized (for example, during step 204 (Figure 2)) so that the common ground provided by conducting layer 108 is electrically connected to the front face of piezoelectric assembly ~~500~~ 400.

AMENDMENTS TO CLAIMS

Please amend the claims as shown in the following listing of claims which will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1 – 15 (Withdrawn).

16. (Currently Amended). A ~~multi-dimensional~~ 1.5 dimensional transducer having a plurality of elements, said transducer comprising:

a conductor;

a piezo-electric assembly on a first side of said conductor, said piezo-electric assembly having a first plurality of cuts in a first direction;

a matching layer assembly having a second plurality of aperture cuts in said first direction, wherein said matching layer is coupled to said conductor opposite said piezo-electric assembly such that said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein said conductor is not severed by said first and second plurality of cuts, wherein said transducer further comprises a plurality of major element cuts in a second direction, and wherein said plurality of major element cuts are made in said piezoelectric assembly and said matching layer assembly, and sever said conductor.

17. (Original). A multi-dimensional transducer according to claim 16 wherein each of said first and second pluralities of cuts is filled with an acoustically-attenuative material.

18. (Currently Amended). A multi-dimensional transducer according to claim ~~17 wherein said piezo-electric assembly further comprises a plurality of cuts in a second direction~~ 16 wherein a flex circuit is attached to at least one of said plurality of elements.

19-20. (Canceled).

21. (Currently Amended). A multi-dimensional transducer having a plurality of elements, said transducer comprising:

a conductor;

a piezo-electric assembly on a first side of said conductor, said piezo-electric assembly having a first plurality of cuts in a first direction;

a matching layer assembly having a second plurality of aperture cuts in said first direction, wherein said matching layer is coupled to said conductor opposite said piezo-electric assembly such that said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein each of said first and second pluralities of cuts is filled with an acoustically-attenuative material, wherein said piezo-electric assembly further comprises a plurality of cuts in a second direction, wherein said plurality of cuts in said second direction comprise major element cuts that isolate said plurality of elements in an azimuth direction, and ~~according to claim 20~~ wherein said plurality of cuts in said second direction further comprises a plurality of minor element cuts.

22. (Original). A multi-dimensional transducer according to claim 21 further comprising a plurality of signal leads, wherein each of said plurality of signal leads is coupled to one of said plurality of elements.

23. (Original). A multi-dimensional transducer according to claim 22 wherein said plurality of signal leads comprises a flex circuit.

24. (Original). A multi-dimensional transducer according to claim 23 wherein said flex circuit is coupled to said transducer prior to the cutting of said plurality of major element cuts.

REMARKS/ARGUMENTS

In the Office Action dated April 29, 2003, claims 1-15 are withdrawn from consideration, claims 16-20 stand rejected, and claims 21-24 are objected to. Claims 16, 18 and 21 are amended and claims 19-20 are canceled. Claims 16-18 and 21-24 (2 independent claims; 7 total claims) remain pending in the application. Amendments to the specification include the replacing of the words "piezoelectric assembly 500" with "substrate assembly 500" and related amendments. The other changes are to correct typographical errors recently discovered. Support for the amendments may be found in the originally filed specification, claims, and figures. No new matter has been introduced by these amendments. Reconsideration of this application is respectfully requested.

In the Office action, the drawings filed on 12/21/2000 are objected to because the drawings, were the case to issue, are not of good quality. Applicants note that formal drawings had already been submitted on October 15, 2002 in the form of a preliminary amendment. Applicants thank the Examiner for the telephonic conference of July 28, 2003 wherein the Examiner indicated that the drawings are acceptable and that this objection will be withdrawn.

35 U.S.C. § 102 REJECTION

Claim 16 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Hayakawa et al., U.S. Patent No. 4,440,025 ("Hayakawa"). Applicants respectfully traverse the rejection.

The Examiner contends that Hayakawa, as well as the other references cited in the office action, discloses each and every element of claim 16. Specifically, the Examiner contends that each cited reference discloses a multi-dimensional transducer having a plurality of elements, said transducer comprising: a conductor; a piezo-electric assembly on a first side of said conductor, said piezo-electric assembly having a first plurality of cuts in a first direction; a matching layer assembly having a second plurality of aperture cuts in said first direction, wherein said matching layer is coupled to said conductor opposite said piezo-electric assembly such that said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension.

However, Applicants note that Hayakawa merely discloses a single cut made through the various layers of a transducer array. Applicants refer to Figure 4 of Hayakawa, where a single

cut is made several times through the various layers, of the Hayakawa structure, identified as electrode 21, piezoelectric element 20, lower electrode 22, and matching element 23. Specifically, each cut severs lower electrode 22.

In contrast, amended claim 16 recites, in part, "said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein said conductor is not severed by said first and second plurality of cuts" (emphasis added). Hayakawa does not disclose first and second cuts. Hayakawa only discloses a single cut (repeated multiple times), and therefore Hayakawa can not disclose first and second cuts that are aligned. Moreover, Hayakawa clearly does not disclose first and second cuts that do not sever the conductor. To the contrary, Hayakawa teaches a single cut that severs the conductor. In fact, Hayakawa teaches away from the transducer of amended claim 16 because by teaching a single cut, there is no need to align multiple cuts. Thus, Hayakawa does not disclose a piezo-electric transducer assembly where separate cuts on either side of a conductor leave a common conductor. Therefore, Applicants submit that each and every element of claim 16 is not disclosed, taught, or suggested by Hayakawa.

Claim 16 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Brisken et al., U.S. Patent No. 4,211,949 ("Brisken"). Applicants respectfully traverse the rejection. As with Hayakawa, the Examiner contends that Brisken discloses each and every element of the multi-dimensional transducer originally claimed in claim 16.

However, Applicants note that Brisken merely discloses a single cut made through the various layers of a transducer array. Applicants refer to Figure 4 of Brisken, where a single cut is made (several times) through the various layers, of the Brisken structure, identified as metallic coating 22, piezoelectric element 21, impedance matching layers 23 and 24. Specifically, each cut severs both metallic coatings 22.

In contrast, amended claim 16 recites, in part, "said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein said conductor is not severed by said first and second plurality of cuts" (emphasis added). Brisken does not disclose first and second cuts. Brisken only discloses a single cut (repeated multiple times), and therefore Brisken can not disclose first and second cuts that are aligned.

Moreover, Brisken clearly does not disclose first and second cuts that do not sever the conductor. To the contrary, Brisken teaches a single cut that severs the conductor. In fact, Brisken teaches away from the transducer of amended claim 16 because, by teaching a single cut, there is no need to align multiple cuts. Thus, Brisken does not disclose a piezo-electric transducer assembly where separate cuts on either side of a conductor leave a common conductor. Therefore, Applicants submit that each and every element of claim 16 is not disclosed, taught, or suggested by Brisken.

Claim 16 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Le Verrier et al., U.S. Patent No. 5,706,252 ("Le Verrier"). Applicants respectfully traverse the rejection. As with Hayakawa, the Examiner contends that Le Verrier discloses each and every element of the multi-dimensional transducer originally claimed in claim 16.

However, Applicants note that Le Verrier merely discloses a single cut made through the various layers of a transducer array. Applicants refer to Figure 3 of Le Verrier, where a single cut is made (several times) through various layers, of the Le Verrier structure, identified as marcher plates 204 and 205, piezoelectric ceramic plate 201, rear plate 202, and electrodes 211 and 221. Specifically, each cut severs both electrodes (211 and 221), or in other words cuts completely through the conductor in at least one portion of the conductor.

In contrast, amended claim 16 recites, in part, "said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein said conductor is not severed by said first and second plurality of cuts" (emphasis added). Le Verrier does not disclose first and second cuts. Le Verrier only discloses a single cut (repeated multiple times), and therefore Le Verrier can not disclose first and second cuts that are aligned. Moreover, Le Verrier clearly does not disclose first and second cuts that do not sever the conductor. To the contrary, Le Verrier teaches a single cut that severs the conductor. In this regard, Applicants note that it is of no importance that the severed conductors may or may not be electrically connected outside of the transducer structure because the conductor is nonetheless cut completely through in at least one portion of the conductor and is thus severed in that area. In fact, Le Verrier teaches away from the transducer of amended claim 16 because, by teaching a single cut, there is no need to align multiple cuts. Thus, Le Verrier does not disclose a piezo-

electric transducer assembly where separate cuts on either side of a conductor leave a common conductor. Therefore, Applicants submit that each and every element of claim 16 is not disclosed, taught, or suggested by Le Verrier.

Claim 16 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Hanafy et al., U.S. Patent No. 6,043,589 ("Hanafy"). Applicants respectfully traverse the rejection. As with Hayakawa, the Examiner contends that Hanafy discloses each and every element of the multi-dimensional transducer originally claimed in claim 16.

However, Applicants note that Hanafy merely discloses a single cut made through the various layers of a transducer array. Applicants refer to Figure 2 of Hanafy, where a single cut 34 is made through the various layers, of the Hanafy structure, identified as matching layers 36 and 38, electrodes 46 and 48, and segments 30 and 32. Specifically, cut 34 severs both electrodes (46 and 48).

In contrast, amended claim 16 recites, in part, "<u>said first and second pluralities of elevation cuts</u> <u>are aligned</u> to isolate said plurality of elements in an elevation dimension, <u>wherein said conductor is not severed by said first and second plurality of cuts</u>" (emphasis added). Hanafy does not disclose first <u>and</u> second cuts. Hanafy only discloses a single cut, and therefore Hanafy can not disclose first and second cuts that are <u>aligned</u>. Moreover, Hanafy clearly does not disclose first and second cuts <u>that do not sever the conductor</u>. To the contrary, Hanafy teaches a single cut that severs the conductor. In fact, Hanafy teaches away from the transducer of amended claim 16 because, by teaching a single cut, there is no need to align multiple cuts. Thus, Hanafy does not disclose a piezo-electric transducer assembly where separate cuts on either side of a conductor leave a common conductor. Therefore, Applicants submit that each and every element of claim 16 is not disclosed, taught, or suggested by Hanafy.

Claim 16 stands rejected under 35 U.S.C. § 102 (e) as being anticipated by Bureau et al., U.S. Patent No. 6,341,408 ("Bureau"). Applicants respectfully traverse the rejection. As with Hayakawa, the Examiner contends that Bureau discloses each and every element of the multi-dimensional transducer originally claimed in claim 16.

However, Applicants note that Bureau merely discloses a two dimensional transducer array where a common continuous ground is between a two dimensional array of piezoelectric

and matching layer elements. Applicants refer to Figure 2 of Bureau, where the conductor is not severed in either the azimuth direction or elevation direction.

In contrast, amended claim 16 recites, in part, a 1.5 dimensional transducer. Bureau does not disclose a 1.5 D transducer, but rather a 2D transducer. Furthermore, amended claim 16 also recites, "said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein said conductor is not severed by said first and second plurality of cuts, <u>wherein said transducer further comprises a plurality of major element cuts in a second direction, and wherein said plurality of major element cuts are made in said piezoelectric assembly and said matching layer assembly, and sever said conductor</u>." (emphasis added). In other words, amended claim 16 recites a 1.5 D array with a continuous conductor for each element (a continuous conductor shared among each of the elevation aperture strips of one element), but a discontinuous conductor as between elements. By way of example, in Figure 6(c) of the present invention, the elevation aperture cuts 504 and 506 do not sever the conductor, but the major element cuts 610 do sever the conductor such that the conductor is cut between successive elements in the azimuth direction but not between adjacent sections of the same element in the elevation direction. Again, the first and second cuts of amended claim 16 (for example, in the azimuth direction, elevational cuts) do not sever the conductor, but the major element cuts (for example, in the elevational direction) do cut through the conductor.

In contrast to Bureau, in amended claim 16 of the present invention, no metallization (conductor) bridge is left between the elements. Thus, mechanical cross talk may be reduced. In fact, Bureau teaches away from the transducer of amended claim 16 by teaching a 2D transducer. Thus, Bureau does not disclose a piezo-electric transducer assembly where separate cuts on either side of a conductor leave a common conductor, but where major element cuts sever the conductor. Thus, Applicants submit that each and every element of claim 16 is not disclosed, taught, or suggested by Bureau.

With respect to claim 18 as amended, which recites, "[a] multi-dimensional transducer according to claim 16 wherein a flex circuit is attached to at least one of said plurality of elements", Bureau does not disclose flex circuits attached to a 1.5D transducer with cuts as claimed in claim 16. To the contrary, Bureau discloses a more complicated system for

electrically connecting to each individual square in the 2D array. Thus, each and every element of dependent claim 18 is independently not disclosed, taught, or suggested by Bureau.

Claim 16 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Sliwa et al., U.S. Patent No. 5,297,553 ("Sliwa"). Applicants respectfully traverse the rejection. As with Hayakawa, the Examiner contends that Sliwa discloses each and every element of the multi-dimensional transducer originally claimed in claim 16.

However, Applicants note that Sliwa merely discloses a single cut made through the various layers of a transducer array. Applicants refer to Figure 2 of Sliwa, where a single cut 5 is made through various layers, of the Sliwa structure, identified as matching layers 6, electrodes 2 and 3, and piezoelectric element 1. Specifically, each cut 5 appears to sever both electrodes (2 and 3).

In contrast, amended claim 16 recites, in part, "said first and second pluralities of elevation cuts are aligned to isolate said plurality of elements in an elevation dimension, wherein said conductor is not severed by said first and second plurality of cuts" (emphasis added). Sliwa does not disclose first and second cuts. Sliwa only discloses a single cut, and therefore Sliwa can not disclose first and second cuts that are aligned. Moreover, Sliwa clearly does not disclose first and second cuts that do not sever the conductor. To the contrary, Sliwa teaches a single cut (repeated multiple times) that severs the conductor. In fact, Sliwa teaches away from the transducer of amended claim 16 because, by teaching a single cut, there is no need to align the cuts. Thus, Sliwa does not disclose a piezo-electric transducer assembly where separate cuts on either side of a conductor leave a common conductor. Therefore, Applicants submit that each and every element of claim 16 is not disclosed, taught, or suggested by Sliwa.

35 U.S.C. § 103 REJECTIONS

Claims 18-20 stand rejected under 35 U.S.C. § 103 (a) as being unpatentable over Bureau in view of Sliwa. The rejection of claims 18-20 are moot in view of the cancellation and amendment of these claims.

ALLOWABLE SUBJECT MATTER

Applicants thank the Examiner for the indication that claims 21-24 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicants have amended claim 21, upon which claims 22-24 depend, to include the limitations of the base claim and intervening claims upon which it originally depended. Therefore, Applicants request allowance of claims 21-24.

CONCLUSION

For the above reasons, Applicants respectfully submit that claims 16-18, and 21-24 are not anticipated by the cited references and that the present application is in condition for allowance. Applicants earnestly solicit a Notice of Allowance at the Examiner's earliest convenience. The Examiner is invited to telephone the undersigned if such would advance prosecution of this Application in any way.

Respectfully submitted,

Dated: July 29, 2003

By: John H Platt
John H. Platt, Reg. No. 47,863

SNELL & WILMER L.L.P.
One Arizona Center
400 East Van Buren
Phoenix, Arizona 85004-2202
Telephone: (602) 382-6367
Facsimile: (602) 382-6070